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ABSTRACT

This paper describes a qualitative study regarding the problem of retaining students in college engineering programs where roughly 50% of students drop out. The study focuses on interviews of students who participated in the pre-engineering program at Auburn University in Alabama. Twenty-four students were interviewed representing the sub-groups males and females, African Americans and Caucasians, as well as students persisting in engineering and those switching to another course of study. Deciding factors for "switching students" included program difficulty, study skills, coping skills, and a lack of familiarity with the work of an engineer. Factors for those "persisting" in engineering were intention to stay in engineering, determination, self-regulating behaviors, coping skills, grades and mental preparedness. Most students faced difficulties in the transition to a more academically challenging college program. Suggestions were made for the development of retention programs that would concentrate on helping students become better prepared mentally for the rigors of an engineering program and help students manage the transition to an engineering major. (Contains 19 references.) (AIM)

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FACTORS RELATED TO PERSISTENCE IN ENGINEERING: RESULTS OF A QUALITATIVE STUDY

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Factors Related to Persistence in Engineering:

Results of a Qualitative Study

As engineering professionals look forward to the 21st, concern has begun to arise that there will be a shortage of well qualified engineers to respond to the need in an increasingly technical society (Jackson, Gardner, & Sullivan, 1993). At present there is not a shortage of young men and women who express interest in the engineering field. The problem lies in how to retain their interest, given that roughly 50% drop out, stop out, or change programs. Even more problematic for a society that envisions equal opportunity for all of its citizens to achieve to the best of their ability is that proportionally more minority students drop out of engineering programs. What is happening and what can be done to retain qualified students?

The vast majority of studies related to this concern are quantitative studies, frequently seeking factors which will predict persistence so that colleges can recruit more successfully. Although researchers have identified significant correlations they cannot describe the causal route. In order to understand more fully why students persist or drop out we need to understand the student's interpretation of his or her experiences related to engineering. Thus, the goal of this study is to understand the students' perspectives on which factors impacted their decision to persist or to drop out of the pre-engineering program at a major state university. Potentially, information gathered from the

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students' own views of their experiences with the engineering program could be used to help develop intervention programs that would directly address the perceived needs and concerns of the students themselves.

Background

The dropout problem begins immediately as the attrition rate of first year students is high across university programs. Tinto (1993) documented that 53.3% of all exiting students were freshmen in his analysis of data from the American College Testing Program, the National Longitudinal Survey, the High School and Beyond Studies, and the Survey of Retention at Higher Education Institutions. The report from the Symposium on the Problem of Student Retention in Engineering (Walker, Benefield, Halpin, Halpin, & Curtis, 1994) addresses the problem regarding engineering students in particular. For AASCU institutions, the 6-year graduation rate was 43.8% for white students and 27.5% for minority students. This rate for minority students is mirrored quite closely by Landis (1988) who reported that only about 20% of minority students who begin engineering actually completed the program. The problem is exacerbated at higher levels of education when one examines the number of African-American students entering bachelor-level or master's-level engineering programs. Astin's (1982) data from the late 1970s indicated that 9.3% of entering freshmen were African-American, but the percentage fell significantly to 2.2% to 3.2% at the master's level.

Why is this happening? Why are we losing so many students? There is a rich literature available (Astin, 1982; Brower, 1992; House, 1992; Pascarella, 1982; Schurr, Ellen, & Ruble, 1987; Tinto, 1993) that addresses these concerns with the university population in general. We also need to examine the special situation within engineering programs themselves and concerns specific to minority students.

Among those addressing particular theories, Schurr, Ellen, and Ruble (1987) investigated the impact of actual course difficulty on attrition and achievement. Their results indicated that a higher percentage of students taking difficult courses and earning a higher GPA remained in school (72% of students with GPA > 2.0 and 27% of students with GPA < 2.0) at the end of the first year. Thus the level of difficulty of courses and the resulting grades had a pronounced effect on attrition which appears to verify Astin's statement (as cited in Schurr et al.) that "even considering the student's initial potential for academic performance and dropping out, their actual grades will have a pronounced impact on the decision to leave or remain in college."

Tinto (1993) described a variety of models that have been utilized to explain the problem of student attrition. The spectrum ranges from models that address personality attributes, placing the emphasis on the individual's ability or willingness to adapt to the college experience, to models that focus on environmental factors.

In developing his model of student departure, Tinto examined what he called "the roots of individual departure." At the level of

the individual student, there are two attributes, intention and commitment, which students bring with them to college that are predictors of degree completion. The higher one's academic or career goals, the more likely a person is to stay the course, although Tinto noted that many college students are uncertain about specific goals and frequently change majors. This condition may reflect growth and development as the student matures. Commitment to work toward goal attainment is also a critical ingredient, involving motivation, drive, and effort. A student may also have a commitment to the institution itself based on the perceived benefits of graduating from a specific school or a commitment via familiarity or family connection.

Once at the university, the quality of the individual's interactions with others has a strong impact on persistence. Four aspects that describe the transition are adjustment, difficulty, incongruence, and isolation. For all incoming freshmen, college life requires adjustment and the ease with which the student can make that transition will influence the decision to stay. Early academic difficulty also has an impact as some students will arrive without a solid knowledge base or good study skills and experience either outright failure or significant struggles with the academic load. Incongruence refers to a poor fit between the student's goals and interests and those of the institution. The academic load may be too hard or too easy, the intellectual environment may not meet expectations, or the student may not achieve a social sense of belonging. If the student does not establish sufficient contact

with either the academic or the social community, the resulting sense of isolation may lead to withdrawal. Thus, once a student is on campus and making the transition, many important factors will need to be accommodated for the student to begin to settle in. A further aspect of settling in regards the group, either academic or social, with whom the student begins to identify. If the group is marginal to the mainstream of campus life, rates of withdrawal may be higher, which is an important factor in considering the college experience of minority students. All of these factors help to clarify why a large proportion of student leaving occurs early in the freshman year.

In addition to personal and interactive factors influencing withdrawal decisions, several external factors are important to consider. Students who commute or have family/work obligations have additional pressures pulling them away from full participation in college life. Hence adaptation to college may be more difficult. Finances also impact persistence with financial problems leading to withdrawal or transfer. Financial aid can enable students to persist, but aid through a work-study situation can lead to a modified level of participation. Thus internal, external, and interactional factors all are involved in withdrawal decisions.

Basically, Tinto's longitudinal model of institutional departure begins with pre-entry attributes such as the individual's family background, prior schooling experiences, and skills and abilities that the student has to bring to the task of university-level education. The early pre-institution intentions and

commitments to both academic/career goals and the institution itself exert an influence on the individual, as do the external commitments which exert a more centrifugal force. Once the student is on campus, the interaction with both the academic and social systems begins to exert its influence. Does the student have positive experiences with both the formal academic setting, the classroom, and the informal interaction with faculty and staff? Does the student have positive social experiences both in informal peer interactions and the more structured types of extracurricular activities? And what is the impact of these interactions on the individual's sense of integration into both the academic and social systems for the institution? All of these events and perceptions again influence the intentions, as well as goal and institutional commitment, of the student thereby heavily influencing any decision regarding departure.

The studies investigating engineering students in particular correspond to many aspects of Tinto's model. A naturalistic study by Woods and Crowe (1984) particularly targeted the difficulties of the transition period for many young engineers. Aspects of poor preparation such as weak problem solving skills and poor time management became immediate problems while some program aspects were incongruent with students' expectations resulting in poor understanding of what was expected of them and the level of work involved. Woods and Crowe emphasized that for the students the theme of the transition period was survival, not unlike the

experience reported by medical students in the Boys in White study (Becker, 1961).

Predictive studies (Gardner & Broadus, 1990; Jackson, Gardner, & Sullivan 1993; Levin & Wychoff, 1990a, 1990b) also substantiate parts of Tinto's model in that academic preparation as indicated by high school GPAs and specific career goals, distinguished between persisters and nonpersisters. During transition phase the awareness and use of student services also distinguished between persisting and nonpersisting groups. However, Hayden and Holloway (1985) found a discriminate function involving five factors--self-ratings of academic ability and leadership, perception of the academic reputation of the institution, use of imagination, information on college procedures, and comfort with predetermined course sequences--possessed a higher discriminating ability than grades or standardized test scores. In a recent qualitative study, Hewitt and Seymour (1991) documented the great similarity in concerns and struggles addressed by both persisting and non-persisting students. They found that persisters manage to develop better coping strategies, but warned that programs may be losing very capable students because of institutional factors which could be addressed as a major focus for intervention.

Studies relating to minority students in particular indicate some additional concerns. Lang (1986) documented serious concerns with the level of academic preparation. He maintained that minority students often have poor skills in writing, communication, and problem solving which become quickly apparent in a new and

challenging environment causing serious disillusionment. His studies also indicated that the students had poor self-discipline, ineffective self-management skills, and poor learning skills. Although Tinto (1993) also documents that minority students had difficulty with academic demands, he suggested that they have more difficulty with the transition issues of finding a niche in social or intellectual groups, incongruence in the college setting, and isolation. Financial concerns are also an important factor for minority students. Gardner and Broadus (1990) documented that minority students work twice as many hours to finance their education. In a qualitative study with Mexican-American students, Attinasi (1989) found that the students themselves identified their major concerns in the transition to college around the themes of getting ready and getting in. However, Turner (1994) documented quite clearly that minority students have a very difficult time feeling at home in a large predominantly white research university. The latter two qualitative studies support Tinto's model in expressing the sense of isolation and incongruence experienced by the students.

In summary, the quantitative and qualitative research and the theoretical models reviewed suggest a wide variety of factors which impact the decision to remain in engineering or to switch. What we want to know is which factors the students consider operative in their own experience of making this program decision.

At present there is a large volume of quantitative research which has sought to establish correlations between a variety of

factors and persistence in engineering programs. The goal of this qualitative study is to explore the relationship between the factors and persistence decisions which the students themselves identify. The value of a qualitative approach in this study is to lift up the interpretations that the students carry of their experiences with the pre-engineering program (Glesne & Peshkin, 1992; Patton, 1990, 1991; Scott, 1991; Seidman, 1991). It assumes that each individual has his or her own interpretation and set of responses to the setting, the people, the structure, and the experiences which impact his or her choice of persisting with the program or changing. Thus a qualitative approach can provide a broad rich picture of the decision process, what affects it, and how it changes over time and in response to specific experiences. The primary benefits may be a deeper understanding of the student's experience of his or her introduction to engineering and clues regarding what types of specific interventions provided at sensitive periods, presented in certain approaches, and particular settings might aid in retention of capable students who might otherwise leave the program.

Method

Presented in this paper are results from a qualitative study of the pre-engineering experience from the perspective of the students at Auburn University, a large research university in the southeastern United States. The College of Engineering is the second largest college within the university and graduates more than 50% of all engineers in Alabama. Total college enrollment in

1994 was 4,084 students with a pre-engineering class of 747 students. This group included 181 females and 566 males with an ethnic composition of 90% Caucasian and 10% African American. Academic standards are strong as the mean ACT Composite Score for the entering pre-engineering freshmen in 1993 was 25.3. Students must complete the required pre-engineering curriculum within 6 quarters. Data from the 1991 pre-engineering class indicate that 55.8% of Caucasian students and 33% of African American students were admitted into the engineering program.

The 24 students interviewed in this study were purposively selected to represent in equal subgroups persisting and switching students, male and female students, African American and Caucasian students. Students who have switched out of the program were identified from an exit questionnaire completed at the time of their withdrawal from the pre-engineering program. Persisting students were randomly selected as far as possible from a representative sample population who had participated in an ongoing quantitative study addressing retention of pre-engineering students. All of these students had been in the pre-engineering program within the past 2 years.

The semi-structured interviews followed a protocol developed initially from a review of the literature on student departures from college, which was then refined through a focus group interview (Morgan, 1988) with upper year engineering students and review by professionals in the fields of engineering and educational psychology. Questions addressed five basic topics:

reasons for initial selection of the pre-engineering program, experiences of the transition period, experiences over the first 2 years of pre-engineering, advice to a student considering pre-engineering, and recommendations to the engineering department. All interviews were conducted individually and in person. The full interview was taped and transcribed. In addition, field notes were written immediately following each interview to document impressions and concerns. Later all transcripts were coded, then analyzed for salient themes. Findings discussed in this paper represent themes found consistently across interviews.

In qualitative research the investigator is the primary research tool. Thus, it is essential to consider what personal attributes might impact the adequate collection and interpretation of data. One such attribute is the status of the interviewer as a middle class Caucasian female which could both enhance and detract from open communication. A second attribute is her status as a naive observer in the field of engineering which enabled her to come to the interviews with few preconceptions of engineers or engineering.

Results

The primary theme that emerged from these interviews for the students who switched out was naivete. The students described themselves as "naive" and just kind of shook their heads. [Student], a young African American male who has switched to information systems commented, "I didn't come in with any expectations. I just came in with an open mind. I never thought

'well, it's going to be like this or it's going to be like that.' I was just going to do my work." Likewise, [student], a vivacious African American female who also switched to the information systems program, stated that "school wasn't that hard for me and I couldn't see it being hard." And even those participating in a pre-college experience did not pick up the clues about the difference in levels of difficulty. One said, "I got a little taste of the hard work when I came to the MITE program, . . . but I was like, well maybe it's not this hard, all the work is not this difficult." The four major topics that arose repeatedly within this theme were issues related to the level of difficulty of the program, to lack of preparedness, to coping skills, and to a lack of familiarity with the work of an engineer. Many of these issues were raised by both persisting and switching students indicating a strong commonality in their experiences.

Program Difficulty

The vast majority of these students came to the university with a strong sense of academic competence. They had performed well in high school, generally displaying specific strengths in math and/or science. As [student], a young African American pre-engineering male, said, "Most students who are in engineering have been at the top of their class. A lot of them have been big shots on campus or what have you. And then you come here and you're thrown in with a bunch of big shots and a bunch of smart people, and you wonder, 'How do I fit in?' I was valedictorian of my class,

and all of a sudden I've got a person on this side and one on this side and they're the same way, and it's either sink or swim."

Again almost all students, both persisters and switchers, remarked on the difficulty of the pre-engineering classes in comparison to what they were accustomed to in high school. The amount of work covered was expanded, the speed at which it was covered was increased, and the class size was multiplied. This change was poignantly described by [student], a young male Caucasian now studying history. "When I got here and I took chemistry--I mean I made As in chemistry in high school--but the way that guy went through it and how fast he went through it and how hard the tests were and my grades in chemistry in college compared to what I got in high school were so different I just panicked. . . . I mean I went to class every day, I went through the book, I highlighted it, I made notes on the book, I took notes in class, I went to the review sessions, but I couldn't pass that class for anything. I finally made a D." Some remarked on how much harder it was to concentrate in a large class with distractions and distance from the instructor. As [student], a young African American female persister described it, "I guess it was just so boring and the class was so big, it was just easier to zone off into other things. . . . I wasn't paying much attention. . . . There's more, so much more, to distract you in a large class than in a small class 'cause you're closer to the teacher." Another impact of large classes was the personal distance the students felt from the instructors. There was little time for individual

questions to be answered during class and many were not used to seeking out their instructor for assistance at another time. [Student], a young Caucasian male, now in building science, explained his experience. "So you weren't really close with the teacher, but you had to go talk to the teacher if you need help and stuff like that and trying to figure that out was kind of different. . . . I just didn't feel comfortable going in there at first, but you have to. Don't worry about it."

Another major difference which the students identified involved the teachers and a very different set of expectations. Although most of the students found the teachers to be a mixture of good and bad, for many the additional element of having foreign instructors exacerbated an already challenging learning environment. Course requirements were also described as being distinctly different from high school. In college they said you have to understand the concepts that are being taught. It is no longer possible to just memorize and fill in the formulas; you have to understand how to apply the concepts. [Student], a young African American male who began the program with a strong desire to be an engineer but eventually switched to business, described his experience this way. "In accounting you've got a lot of stuff to memorize but once you memorize it you've got it. With physics and engineering you can't memorize it. You've got to understand the concepts and apply it to different situations." [Student] , now enjoying a history major, also recognized the different level of problem solving required. "Here you take math and science because

you need to take math and science, because you've got to use it. So the people that take it are the people that really know what they're doing. I mean I can memorize all the formulas and anything I want to learn and the equations, elements, and things like that, but as far as putting them into some practical use, I'm really not cut out for that." Part of this difference in expectations is experienced through assessment where the teachers are said to give problems which they did not go over in class. [Student], a Caucasian pre-engineering female who still vacillates in her choice to be an engineer, described her experience with exasperation. "Most of my classes are like that, where they teach you and you can do the basic stuff and they give you tests and it's 10 times harder and more. But my father says they have to do that to see if you know it, to see if you can apply it to harder problems. . . . I think they should teach you the harder problems if they expect you to be able to do them on a test." Other pre-engineering students such as [student], however, see that it needs to be different. "It's just having an open mind, being able to look at it and you just can't--you just gotta be able to reason things--you can't just look at it and say, 'Well, gosh, what's the formula?' When a problem gets so large that you--like there are several steps and you get an answer for this step and then you have to turn around and apply it over here and back and forth to different parts and then it took all that to get the final solution--that trips a lot of people up, especially early because they're used to high school where you get number one, do this, and

that's your answer." Far more is being asked of the students than they were previously accustomed to, but few students described how one learns to make the switch to applied problem solving from following a clearly laid out pattern. Is it that some students cannot make this switch or simply that they move on before they have the opportunity really to understand how to address problem solving?

Another area of difficulty which emerges from this encounter with a more difficult program is the resulting grades. Almost all of the students reported a drop in grades if not immediately, then a term or two later when they try to balance the academic and social opportunities at the university. One of the most glaring differences between students is in their responses to this drop in grades. Most are not pleased with this occurrence, but some immediately take this situation up as a major challenge and bend their efforts to overcoming this obstacle. It is seen as a large challenge and they decide to take it on. Some meet with success and continue with their program. [Student], a young African American female who is persisting with the pre-engineering program, described her experience. "Having a good strong high school background and then coming here, I guess, keeps the pressure on you with people thinking, 'Well if you can do that in high school, you can do that well here; just put your mind to it.' And you put your mind to it, but you don't see the same results as in high school. It's two different environments, settings, whatever, but it was something I had to deal with. At first I was like 'there's really

nothing else I can do. I've given it may all. I don't know how to do any more.'. . . and I was like, 'I can't do this--college is not for me--I can't do this.' But the more I said that I thought, 'What are you saying--I made it this far. Just keep going.' So I became more determined, put more time into it, devoted more to it, and I was happy." On the other hand, some interpret the grades personally as an assessment of their fitness to continue in engineering. For [student], a young African American woman now in aviation management, the interpretation was of inferiority: "I felt inferior because I felt I wasn't as smart as a lot of those people." [Student], however, revealed her deep ambivalence which remained unsettled at the time of the interview: "I guess the part that starts making you run . . . especially people who are smart and used to getting good grades, and get bad grades and think--ahhh, I don't belong here." Yet another response pattern is exemplified by an adjustment in expectations that although they may not be as quick as some of their fellow students, if they plug away long enough and hard enough they too will get the concepts and they will become engineers. [Student], an African American persister exemplified this approach. "This calculus class is, seems like everybody in the class is, like a step above. It's like they know the answers before the question is asked. I don't know how, but it doesn't bother me, but it just seems that way. I just study harder."

Study Skills

The second issue raised by most of these students was that the study skills which got them through high school were no longer sufficient. Almost everyone remarked on the fact that the same effort did not issue in the same outcomes. [Student], a Caucasian persister with a long range goal of a doctoral degree in engineering, described his experience. "I went through high school with a 4.0 . . . the whole 9 yards, and I came here on scholarship the first year, and I didn't really--well I guess my first quarter or first 2 quarters are not really something I would want to show to people. But . . . the academic transition didn't really kick in until spring, and that's when I realized that actually the studying was like four or five times what it was in high school, which was a big leap." When thinking back on their high school careers, many remarked on the fact that they really did not have to study very hard. Reading material over the night before the test had often been sufficient to produce a good grade, as [student], a young African American switcher, explained. "My first quarter here I thought I could do the same kind of studying that I did in high school, but . . . you have to really study from day to day in engineering. In high school I just studied . . . before the tests or whatever and just whenever." But even those who came from good high school programs said that they had to do more than ever before. Part of the difference was attributed to a "high school mentality" which meant that the teachers and parents were going to take care of you. [Student], a young African American man now in

civil engineering, explained: "It took me a long time to get adjusted to the academics because . . . in high school the teachers were like 'do your homework; do this; if you don't we'll put you in detention hall.' And here the professors just give you the assignment and leave it up to you to do it. Whether you do it or not is up to you 'cause it's gonna be on that test whether you know it or not. And that was the biggest adjustment, not having anybody to look over my shoulder. High school is like they made you do it and here you have to want to do it in order to succeed."

Coping

This brings us to the next issue--coping skills. Here there did seem to be a difference between persisters and switchers, with the persisters moving more quickly toward developing coping skills in this new environment. How does one cope with an academic problem possibly for the first time in one's life, in a brand new environment, and where one is just taking the first steps toward independence? For some, it is a very uncomfortable dilemma. [Student], a switcher, painted this picture. "It was the biggest shock 'cause I had never had trouble. If I wanted to sit down and memorize something, I would memorize it. For the first time I found a class that, maybe, was above my head, and that was a shock in and of itself 'cause that had never happened before. I wasn't prepared for it 'cause it had never happened before. You know, if it had happened in high school, I could have figured out a way to deal with it, but it had never happened. So you're in college, you're by yourself. Who are you going to talk to about that? Can't call Mom

and Dad. 'Study harder son' or 'do this or that.' You know. I had this aura of helplessness, a kind of cloud, a huge cloud hanging over me the entire quarter. You know--what am I going to do? I've only got so many weeks left." Some students had been reluctant to seek help, again stating in various ways that they just weren't used to it. [Student], a male Caucasian business student, explained his thinking. "They made it clear that study help was available through the College of Engineering. I just never pursued it. I think it was an open invitation. I don't think I was intimidated. I think most of my problem was admitting that I couldn't do it. I had a problem with that." [Student] also expressed her reluctance to admit to having academic problems. "The engineering department had some support services, but I couldn't connect. I mean, I was really unwilling to get help. I knew that I needed help, but I was not used to asking for it because I never had to ask for it before. I had people ask me how to do stuff, but I've never had to go up and ask someone, 'can you tell me how to do this?' So, therefore, I was very reluctant to do it. Very. But now I will ask anybody, because I know that I must understand what I am doing in order to get a good grade. I don't like not understanding." The experience of having to ask for help was a new experience and for some a significant hurdle. Because all of the students were new, individuals did not have a good sense of how other students were doing and some expressed the concern that maybe they were the only students failing the course, when in actuality many students were experiencing difficulty. [Student], now in civil engineering,

described her thoughts during the early days of the program. "At first I thought, you know, the rest of the class is making As. . . . I was just thinking maybe everybody else is better prepared for this, or everyone else has gone to a better high school, or something . . . but then our chemistry teacher showed us the grades and how they panned out and I was average." Uncertainty, isolation and fear were common reactions as [student] eloquently expressed. ". . . when you're first here, you're as scared as everyone else. Everybody else is so scared about classes. You sit in class and you're all quiet and you don't talk to the people next to you, you don't talk to the people in the halls about classwork, you don't know them. . . . I think it would have helped a lot of people get through stuff to talk about their problems. Then people would have realized--I would have realized--that I wasn't the only one having problems. . . . As far as I was concerned, I was the only one making a D in this entire university. I'm going to be the only person that fails out. If I had known that I could have talked to someone, I would have felt a lot more comfortable." Here is where the importance of the peer group surfaced. If a student's new friends were in engineering, then there were both a support group for coping with the heavy work load and resources for addressing problems together. But for those whose friends were in other majors, there was a double bind. First, they were struggling with the increase in their own work load over anything they had experienced prior to this time, but, secondly, many expressed frustration at the lighter work load of their friends who could do

their work, make good grades, and still have plenty of time for socializing. [Student], who is persisting in engineering but continues to waver described her frustration. "All my close friends that I met freshman year weren't in engineering. They're in education and psychology and other things. They would all go out all the time and I'd be home studying and studying and then when it didn't pay off and they were making better grades than me, I was frustrated!"

One of the important coping skills is good self-management. Some students like [student], under advice from family members usually, began their university program with a balanced approach. They scheduled classes so that they would not have an especially heavy class load and took less than the recommended load at least for the first quarter to help make the transition to college life. [Student's] description: "My dad was in on scheduling my classes and stuff. . . . I guess I actually took a lighter load, a few hours short of what the normal people take . . . so it was definitely not the engineering load . . . but I think that now I can adjust. . . some people tend to go overboard," represents a kind of go-slow approach. Conversely, [student], who is now out of engineering, bemoaned her start pattern "that makes me mad now when I look back and see that I could have done it if I only . . . paced it well. . . . I was naive when I went into it taking 18 [hours] not knowing anything, then I took 21, and I went over my head." Several students took the departmental advisors to task for recommending heavy class loads during the early quarters. Others

reported that this first experience of self-management was a real challenge. Never before had they been responsible for themselves, and the freedom that comes with university life was too much to manage all at one time. "It was just different, because you're used to living at home. Your parents support like, totally. You still get parents' support down here, but you've got to make decisions on your own, you know--when to come in, when to study, when to leave where you need to leave, or whatever, you know, got to get up for classes, and stuff like, basically, I guess you do it somewhat in high school but you don't, I mean still if you oversleep or something your mom can wake you up." For several of the interviewees and many of their acquaintances, this situation plunged them into early academic trouble from which they could not recover sufficiently to retain a place in the program.

Many of the students who eventually switched out spoke of how "intimidating" the program was. One such person was [student], a persister, who reflected, "I think one thing that makes people drop out is, they're very intimidated right off the bat because they're taking three impossible classes right to start with. . . . Plus you hear all these upperclassmen, not necessarily engineering students . . . say, 'Oh, engineering is just so hard'. . . and you've got to take all these impossible classes, and you hear titles of courses and big words you've never heard of before." The message that this program would be hard came from many sources: the department itself, fellow students who said that "engineering's so hard. How can you do that?", and upper-year students who said, "It gets

worse." When struggling at the transition level and trying to adjust to the increased workload and increased expectations, the promise of more of the same if not worse in the not too distant future seems more than one is prepared to cope with and students start considering the choice to switch out.

But even the choice to switch out is fraught with complications. Students in general have a high opinion of engineering. They recognize it as a difficult course and the engineering students themselves feel a sense of pride that they are in an esteemed group. How then does one leave this self-chosen goal behind without a sense of having failed and settling for second best? Many of the students who eventually switched made the move out slowly. They hoped they would be able to learn to do the work and pull up their GPA in order to retain their place, but for many it was a long uphill climb, especially if they had really had academic problems the first few quarters. A number of students describe a struggle to do the work, contemplation of other options, talking with friends and family about how to resolve this difficulty, and often a sense of relief finally to let go of the engineering option and follow another course that frees them from the heavy burden they sense themselves to be carrying. [Student] suggested a loss of prestige: "It might have taken me longer to switch into business because there's an attitude that business students aren't as studious as the engineering students here or it's not as difficult or it's not looked upon as prestigiously as engineering. That might have taken me a little time to think about

it longer." [Student] emphasized the difficulty of giving up a goal: "I have the mentality that I'm not gonna give up. Even when I decided to change my major, it was hard to change because . . . I'm the type of person, if I start something, I want to finish it out. I don't want to feel like I gave up on it. . . . I didn't want to seem like a failure by leaving the engineering program." And [student], while expressing disappointment at not meeting a goal, was able to articulate the positive aspect of finding a program that brought peace of mind and satisfaction. "At first [I was disappointed] 'cause I was just so set on graduating from aviation management. You know you set those goals and then when you don't meet them you kind of, you know, it hurts your feelings at first. But as soon as I got out and I realized everything was going to be okay, it was like the biggest burden lifted off my shoulders. I was finally going to get to do something that made me happy and that I was starting to get good at. And my grades increased little by little."

Help is definitely available. The engineering department and various organizations such as the National Society for Black Engineers offer a range of student services, from advising to tutoring and study groups. [Student], a persister, expressed her experience this way: "NSBE has been really helpful. . . . If you have a certain teacher and you don't understand their teaching methods or their style, there's going to be somebody in the group who had the teacher and perhaps they have old test files they'll go over with you. . . . Everyone is so helpful in that organization.

. . . I don't know where else to go." However, a good number of students do not seem to get the message that these services are available. [Student], now a textile engineering student, recalled that "they have signs up all over campus, but I just never noticed them. It wasn't until I got into physics and I thought I needed them that I started looking at things and realized there were tutors here." Many students did not know about advisors or study help and attempted to work it through on their own. Some prefer to work alone; thus, even if they know about services they do not generally take advantage of them. And as mentioned previously, some are reluctant to admit that they are having academic problems on their first foray into independent living.

What do engineers do?

The fourth issue that is part of the general sense of having been naive is a lack of understanding of what it is that engineers actually do. Many of these students chose engineering because they had academic strengths in math or science, families and school personnel recommended it as a "good field," or they recognized that engineers have a position of prestige in society and good remuneration. However, they had very little appreciation of what the daily work of an engineer actually is. Most have had very little experience with engineering tasks and found that their pre-engineering program did not generally introduce them to the world of the engineer. This was not the case for students in smaller departments, such as textile engineering, where students had the opportunity to get acquainted with engineering faculty their first

year or chemical engineering which has a class specifically designed to introduce the student to the world of the chemical engineer. Reactions to such classes were somewhat mixed with some students reporting that speakers were often too far beyond their level as first year students to help them grasp industrial implementation. Many students chose to co-op specifically to try out engineering in practice to see if they would like it. Even those, like [student], who stated that they were very committed to engineering from the beginning made it clear that the delay in getting to actual engineering classes had many of them considering optional programs. "It takes so long to get into an engineering class, you don't even know what engineering is . . . and then I had Physics 222 . . . and I hated it . . . and I started to think maybe engineering's not for me . . . because I didn't know what was going on...but now I'm in circuits and it's easy. . . . Until you get into your first classes you don't really know."

All of the students commented on the struggle to adapt to the pre-engineering program. Simultaneously they were faced with basic issues of university transition encountered by all freshmen plus coping with a significant increase in level of difficulty, realization that current study skills were inadequate, reliance on fledgling coping skills, and a classroom program that was incongruent with their expectations for some experience of engineering.

Factors Related to Persistence

Although a majority of the students--both persisters and switchers--reported similar concerns and difficulties as they struggled with the transition to pre-engineering, there were a number of topics raised which illustrated some of the self-perceptions and actions of persisting students. For example, the pre-entry attribute of initial level of intention showed surprising strength. In addition, terms such as "being mentally prepared" and "determination" captured some of the self-definition, and behaviors such as development of coping skills and demonstration of self-regulation surfaced in the self-descriptions.

Intention

Even from the beginning, some of these students have firmly declared their intention. Their goal is to be an engineer, not just to try out the engineering program. Thus, initial intention has far reaching implications in persistence decisions. Of the 12 students who stated that they came to university with a strong desire to be an engineer, 8 remain in the pre-engineering program. Although their reasons vary, the striking part of their discussion was their elaboration of reasons which combined academic strengths in math and science, engineering related experiences, gathering information on engineers and engineering from a variety of sources, and practical applications such as envisioning themselves performing practical applied work. Of the 12 students who stated that their primary goal was to "try it out," 4 remain in the program. Although they also mentioned academic strength in math and science, other reasons were more peripheral--good field, good income, family

promoted it. Although the statements appeared strong and thoughtfully considered, they are "after the fact" declarations which, therefore, should be viewed with caution. Comparison with data from the ongoing quantitative study may help to verify these intentions.

Determination

The importance of determination was a common topic, especially among the persisting students. They frequently mentioned it in their discussion about the difficulty of the program, dropping grades, the wide variability in approachability among the teachers, and adjusting to novelty on many levels and many fronts simultaneously. As [student], a young African American female who is persisting, commented, "My goal is still to be an engineer. There are times I call home crying, all the time about how hard it is, but if it's something that I really want, then it's something that I'm determined to get." For a number of these students, difficulty was perceived as a challenge and they liked that--responding to a challenge seemed to energize them--"that's why I'm sticking with it . . . it's not easy . . . it's something I have to apply myself to and that intrigues me." In addition, this challenge brought out a competitive nature, but not in a cut-throat type of competition. Some students, like [student], reported more of a friendly competition with friends: "I have this competition thing going on with myself . . . like if someone is in the same curriculum . . . a friend or associate, we compete to see who can make the better grades, and it's good in a sense because it helps

you, pushes you." Thus, for some the difficulty seemed to focus their attention and energize them to "take on" an obstacle to their chosen goal.

Self-Regulating Behaviors

One of the striking self-descriptions was articulation of academic coping strategy. When asked about how they coped with problems, a group of seven of the persisting students were able to articulate clearly the steps that they would go through to overcome an academic problem. It was evident that they owned their particular strategy and would activate it whenever the need arose. [Student's] version was: "The first thing I did if a problem arose in a classroom, I would go to someone who had the class before, maybe the same teacher or . . . had As in those type of classes. I would go and say 'this is what I'm doing. Can you tell me what I'm doing wrong?' . . . and if that didn't work, I would go to the teacher and tell her what I did as well as what someone else helped me with. I got a tutor and I said, 'I still don't understand.' and that's when, when I reach that point I go to the teacher . . . I'm at the point I'm all in it then and nothing will stop me." For many of these students, there was no doubt that anyone survived engineering going it alone--all of this group had a system of steps or a network of people to call on for assistance. Many of these students sought out their professors, advisors, or upperclassmen, or joined engineering organizations such as the National Society of Black Engineers which provided a network of people to call on for assistance and guidance. This is not to say that all persisting

students displayed these characteristics. Some preferred to work alone, but a majority of those students who worked alone but did persist in engineering also reported that they would seek out professors for assistance, but preferred not to join study groups or organizations.

Coping Skills

Half of the persisting students reported that most of their friends were in engineering or that they knew students in the department or in related fields before they arrived on campus. These social contacts prove to be significant when compared with the loneliness and isolation experienced by students whose friends were in other fields or who did not know anyone on campus. This group did not experience the centrifugal pull of associates with an apparently less demanding program, better results, and a lively social life.

Grades

Although getting poor grades seems to be a major reason to consider switching, the opposite can also be true: getting good grades can influence a student to stay the course even if there is uncertainty that this is the direction really desired. [Student's] experience provides an example. "I've never really been interested in computers. It was my uncle actually pressing me--'go into that,' and I was like 'No, no, I don't want to do that.' But then I thought that'll be a pretty safe bet for the job market." Five of the persisting students specifically reported that they were making good grades now in their engineering classes, while other

persisting students reported that they had adapted to an acceptance of different levels of ability and comfort with their own pace and level of achievement. [Student] had adopted that notion of the slow but steady pace. "I get it a little bit slower than everybody else but I show that I don't get it, you know, 'I don't understand,' where everyone else would just be quiet, but I'm just not like that. . . . I don't get too discouraged; everybody learns at a different pace. Long as I can pass the class and do as well as I can, then that's all I can do."

Mentally Prepared

Last but certainly not least in the characteristics of persisting students and in the comments of switchers is the need to be mentally prepared when you arrive for pre-engineering classes. Both groups of students remarked that there was little to no time to get prepared once you were here because the pace was fast and you had to put work habits, self-management, study skills, and coping skills into play immediately. They stated that if you were "mentally prepared" to face a difficult program, then you would fare much better.

Themes Unique to Females

The major theme that appeared unique to females was the personal factor. Social relationships had an influence on their initial choice of engineering in that 8 of the 11 students who had a family member who was an engineer were female, but primarily the personal factor arose in the desire for personal recognition within a very large department. To five of the women students, it was

important to obtain personal recognition from the teacher, and more females than males spoke of the usefulness of organizations and study groups in coping with the transition to the program. Females were also more likely to have friends who were not in engineering, and to feel the division in their social and academic worlds.

Themes Unique to African American Students

The most striking theme among African American students was the difficulty coping with juggling work and studies. Eight of the 10 students working regular part-time jobs were African American, and over half of them reported that for at least a part of their pre-engineering career they worked at tiring minimum-wage positions in fast-food restaurants. At the time of the interviews, all but three were employed on campus in tutoring, dorm, or library positions which allowed for some study time or at least review of basic level skills.

A second theme highlighted more feelings of isolation among the African American students. For some this was a first experience in a large majority white educational setting, and some expressed the sense of not belonging. For some, association with NSBE was a definite positive experience which provided a strong supportive network and familiarity, but for those whose style is more of a individual approach, gaining a sense of belonging was problematic. This feeling may be compounded for African American women as they were more expressive of these needs for a social network.

Summary of Recommendations From Students

As part of the interviews students were asked to consider what factors might have made a difference in their experience and what recommendations they would make based on those factors. In their recommendations for a new student, interviewees basically reiterated their own experiences and concerns by emphasizing the importance of dedication, hard work, strong study skills, and a solid background in math and science. Both persisting and switching students would recommend that an interested student give the program a try, all the while remembering that there are other options. Advice from switchers alone was to be willing to ask for help.

In their recommendations for suggestions at the high school level that would be helpful to a student considering engineering, the students included: invite speakers to talk about what engineers do as well as engineering programs; invite engineering students to talk about their experience with the program, both the good and the bad; campus visits; and high school classes that introduce students to a major such as engineering.

One of the major themes in the advice to the engineering department itself addressed the need expressed by a majority of the students for mentoring. This need was approached in a variety of ways - a need for encouragement and guidance from upperclassmen, a need to know advisors and teachers early in the year, a desire for small groups within each major to be created during orientation to enhance personal interaction and help create a sense of belonging,

and a need for teachers to be more approachable and demonstrate interest in the student's well being. For some students, such as [student], who had a stressful experience in pre-engineering, their recommendation was forceful: "You have the freedom to go to your advisor anytime you want to, but I think they ought to make you go. Because you're a freshman, you're so scared about having to go and tell someone that you're making an F in a class, that it scares you away from going to talk. I think they ought to make it mandatory. They ought to make you go there and make you talk about it and help you, and after that they can realize that that's what they're there for--to help and they'll (students) go on their own." [Student] reflected his own experience: "Just make sure that everyone who comes here knows that you're not expected to get this stuff by yourself. Make sure they know there are tutors around and where they're located. Basically I had the mind set that I didn't need any help, . . . and that's why even when the stuff got really hard I just thought if I just keep reading it I'll get through it . . . make sure they understand that they shouldn't go it alone."

The second major theme was to request that the department provide more opportunities for the pre-engineering students to experience what engineering is really about. The students requested information on what engineers do and hands on experiences of engineering which could be partially accomplished through introductory classes such as those in textile engineering and chemical engineering (although those classes themselves received mixed reviews from the interviewees from those departments). "Just

need to give them a taste of engineering when they get here so at least they'll know what's going on," opined [student]. He also declared how difficult it was to take classes that seemed essentially uninteresting and unrelated to their concept of engineering. This view was echoed by many students who recognized the motivational value of taking classes in their major.

Conclusions

The experiences of these young students portray the tempestuous transition to the pre-engineering program. Many aspects of Tinto's model are illustrated in these students' narratives and experiences. The pre-entry factor of commitment to a particular goal is strikingly exemplified in the persistence rate of those committed students. As they arrive on campus and begin their pre-engineering experience, other obstacles begin to loom. For pre-engineering students in particular, the obstacle of level of difficulty has special meaning. These students are faced with a very heavy academic load--one which the vast majority of them had not encountered before and one that many of their non-engineering peers did not have to address. Difficult courses are compounded by large class size and increased distance from the teacher. Most students reported that their high school study skills do not suffice in the university situation; thus, these students are having to learn a variety of new patterns of behavior--study skills as well as seeking out and asking for help. For most, this encounter with the level of difficulty and emphasis on math, chemistry, and physics meant that there was not a congruence

between what was expected and what was found. In addition, they faced the major incongruity of a change in grades. Although Schurr, Ellen, and Ruble (1987) have documented the correlation between course difficulty, low grades, and persistence decisions, these students' reactions made it clear that interpretation of poor grades was a significant factor. This situation may be reflecting motivational style as described by Dweck (1983) in that the "performance" oriented students interpret difficulty as an obstacle and a sign of inability to meet the task, then seek a new location where their performance can be publicly acknowledged to be good and "learning" oriented students see difficulty as a challenge that they can begin to address incrementally through increased effort. Can we change students' motivations?

Did the student find a social niche? In Tinto's model finding a compatible group is an essential factor in making the transition successfully. A complicating factor for these students is that, although they may find a compatible group socially, there not being a good match in terms of academic lifestyle can be an important factor in withdrawing from engineering. Minority students in this study described problems of isolation and often a slower adjustment to campus as they gradually found a compatible circle of friends.

This transition is one fraught with many challenges, and the sooner one develops coping skills, the higher the comfort level achieved. Results of these interviews substantiate the finding of Hewitt and Seymour (1991) that persisters develop better coping strategies. They tended to be the ones who would initiate new

patterns of behavior in seeking help while many switchers reported that they were slow to overcome their reticence to admit to difficulty and became mired in difficulty and frustration.

What are the implications of this study for development of retention programs? It would appear that the two primary areas are getting prepared (i.e., being mentally ready) and managing the transition. Contacts with prospective students need to build realistic perceptions of what the engineering program is like and what the world of engineering is like, and they need to demolish myths. One myth is that being good in math and science is what it takes to be an engineer. The majority of these students considered themselves strong in math and/or science as well as interested in one or both areas, but the level of conceptual thinking and degree of difficulty appear to be more basic in deciding to persist. Helping these students to elaborate their conception of engineers and engineering may help them to make better, more informed choices regarding the match with pre-engineering.

Managing the transition appears to be the crucial intervention territory. These students have clearly stated the problems they encountered on many levels and their primary request is for guidance. A strong transition program for at least half of the first quarter would provide a structure, guide and support system for these students as they encounter difficulty with the potential of teaching them valuable coping skills and engendering an attitude of confidence. This program could involve small support groups to aid social interaction and establishment of a peer group within the

engineering department, to provide information regarding availability of support services, to address study skills and time management, to air complaints and obtain constructive feedback, and to provide accurate information about the widespread incidence of academic struggles, to learn how to make the transition from a memorization strategy to a problem solving strategy, and to weather the first round of tests and labs with a strong support system. A mentoring system may be another vehicle for aiding students in the transition. Those involved could even be students just 1 year ahead or just entering the engineering program who would be able to speak knowledgeably about the difficulties, challenges, and avenues that others have found that help one to adapt and succeed.

The final suggestion is to provide more experiences of engineering activity during the pre-engineering phase of the program. Many of the students were seeking experiences that would give them more of a sense of what engineers actually do so they could determine better whether to persist with the rigors of the program. Engineering projects might help to maintain motivation for engineering across the long series of basic science courses that comprise the pre-engineering program.

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